

Pre AP S'mores Lab; Limiting Reagents

Purpose: To investigate limiting reagent reaction and utilize knowledge of wet lab chemistry to synthesize a delicious treat.

Introduction: It is obvious to the most casual observer that making the exquisite delight, La s'more, is not child's play. In fact, it is a study of quantitative relationships involving stoichiometry and should only be undertaken by persons of sufficient training.

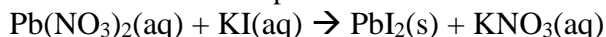
Pre-lab Questions:

1. What are the main components of a written chemical equation (reaction)?
2. Define the terms limiting and reagent mean. Together they (limiting-reagent) means (in your own words and textbook definition)?
3. How is theoretical yield different from actual yield?
4. How do you think they, theoretical and actual yields, are both helpful in working with chemical reactions?
5. What is percent yield? (include a formula)
6. Use the following recipe to perform a synthesis reaction using your ingredients.
Recipe for 1 S'more (Sm)
2 graham cracker halves (chemical symbol Gr)
1 chocolate bar (chemical symbol Ch)
1 marshmallow (chemical symbol M)
7. Write a balanced equation for your reaction using the chemical symbols given. Remember that the coefficients represent how many "moles" of each reactant and product you have. This balanced equation (recipe) will be used to answer the following questions (8-12)



8. If a student had 7 moles of chocolate bars how many moles of marshmallows would, be needed for a complete reaction?
9. If Jenny was tasked with bringing graham cracker to a fireside chat to make S'mores. She only brought 24 graham crackers, what is the theoretical yield of S'mores that can be made based on the graham crackers she provided? **Use Stoichiometry!**
10. If Jenny's friend Chris brought 10 chocolate bars, what is the theoretical yield of S'mores that could be made? **Use Stoichiometry!**
11. If Jenny and Chris's teacher provided excess marshmallows, what *limits* the number of S'mores that can be made? Provide proof.

12. Using the same techniques (stoichiometry) you did for determining questions number 9-11, what limits the production of lead (II) iodide in the reaction below when 3mole of lead (II) nitrate is reacted with 3moles of potassium iodide?



- What is the limiting reagent?
- What is the non-limiting reagent or excess reagent?

Advanced Lab Procedures:

You can use a paper towel as a clean surface for your ingredients.

Step 1) Break your graham cracker into 2 pieces and a) break your chocolate into 4 pieces if using chocolate from a full size bar, if given a single unit do not break apart.

Put your chocolate onto 1 of your graham crackers.

Step 2) Roast your marshmallow over the Bunsen burner with the wood splint – **DO NOT Let Marshmallow Catch On Fire!**

Step 3) Quickly place the marshmallow onto the chocolate pieces and cover it with your second Graham cracker. Wait for it to cool and enjoy the sweet taste of success in chemistry!

Data: draw AND describe the reactants, products, and reaction mechanism

Analysis/ Post Lab:

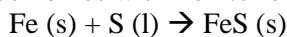
For questions 1-4 use prelab question 7

- Given 18 squares of Chocolate, how many S'mores can you make if the other ingredients are in excess?
- If you wished to make 3.5 S'mores, how many Graham Cracker Halves would be needed?
- Given 7 Graham cracker halves, 2 marshmallows and 20 squares of chocolate:
 - What is the limiting ingredient?
 - What is the theoretical yield of S'mores?
- While doing the experiment described in question 3 above some sugar-starved low life steals some of your ingredients and you are only able to make 2 S'mores. What is your percent yield?

For question 5-7 use prelab question 12.

- What is the theoretical yield of lead (II) iodide in question 12?
- How many moles the non-limiting reagent are used?
- How many moles of the non-limiting reagent are remaining after the reaction?

8. At high temperatures, sulfur combines with iron to form the brown-black iron (II) sulfide:



In one experiment, 7.62 g of Fe (MM 56g/mol) are allowed to react with 8.67 g of S (MM 32g/mol).

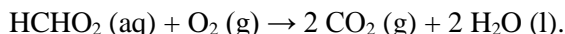
- What is the limiting reagent, and what is the reactant in excess?
 - Calculate the mass of FeS (MM 88g/mol) formed.
9. Acrylonitrile, $\text{C}_3\text{H}_3\text{N}$ (MM 53 g/mol), is the starting material for the production of a kind of synthetic fiber acrylics) and can be made from propylene, C_3H_6 (MM 42g/mol) by reaction with nitric oxide, NO (30g/mol), as follows:



What mass of $\text{C}_3\text{H}_3\text{N}$ can be made when 21.6 g of C_3H_6 reacts with 21.6 g of nitric oxide?

10. Calculate the percent yield for the reaction: $\text{P}_4 \text{ (s)} + 6 \text{Cl}_2 \text{ (g)} \rightarrow 4 \text{PCl}_3 \text{ (l)}$ if 75.0g of phosphorus reacts with excess chlorine gas to produce 111.0 g of phosphorus trichloride (138 g/mol).

11. Formic acid, HCHO_2 (MM 46g/mol) burns in oxygen (32g/mol) to form carbon dioxide (44g/mol) and water as follows:



If a 3.15-g sample of formic acid was burned in 2.85g of oxygen, what mass of carbon dioxide would be produced?

12. Zinc metal reacts with hydrochloric acid to produce zinc chloride and hydrogen gas.

a. Balance the following reaction: $\text{Zn (s)} + \text{HCl (aq)} \rightarrow \text{ZnCl}_2 \text{ (aq)} + \text{H}_2 \text{ (g)}$

b. A 3.50-g sample of zinc metal is allowed to react with 2.50 g of hydrochloric acid.

Complete the following table:

Reactants/products	Zn (grams)	HCl (grams)	ZnCl ₂ (grams)	H ₂ (L)
Before reaction				
After reaction	1.26 g			

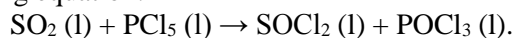
13. Consider the reaction:



If 0.45 mols of MnO_2 (MM 87 g/mol) can react with 48.2 g of HCl (36g/mol), how many grams of Cl_2 (70g/mol) could be produced?

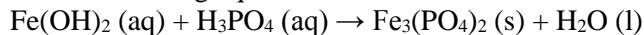
- $$2 \text{N}_2\text{H}_4 (\text{l}) + \text{N}_2\text{O}_4 (\text{g}) \rightarrow 3 \text{N}_2 (\text{g}) + 4 \text{H}_2\text{O} (\text{g}),$$

15. Calculate the percent yield for an experiment in which 5.50 g of SOCl_2 (MM 118 g/mol) was obtained in a reaction of 5.80 g of SO_2 (MM 64 g/mol) with excess PCl_5 . Use the following equation:



- a. Balance the following equation: $\text{Cl}_2(\text{g}) + \text{SiO}_2(\text{s}) + \text{C}(\text{s}) \rightarrow \text{SiCl}_4(\text{l}) + \text{CO}(\text{g})$

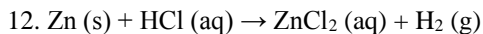
- a. Balance the following equation:



- c. How many grams of $\text{Fe}_3(\text{PO}_4)_2$ precipitate can be formed?

- Some Answers:

9. 25.5 g $\text{C}_3\text{H}_3\text{N}$ 10. 33.3%



Reactants/product	Zn (grams)	HCl (grams)	ZnCl ₂ (grams)	H ₂ (L)
Before reaction	3.50	2.50	0	0
After reaction	1.26 g	1.26	4.67	0.768

- b. 14.0 g CO gas

- b. $\text{Fe}(\text{OH})_2 = \text{LR}$, H_3PO_4 NLR

- d. 94.0%